PolyCerNet is a Marie Curie Research and Training Network coordinated by the University of Trento, Italy, which will study molecularly-tailored, nanostructured ceramics with unusual multifunctional properties, including photo and electroluminescence, semiconductivity and many kinds of gas-solid interactions, for example sensing, catalysis, and molecular sieving. In addition these novel, polymer-derived ceramics, or PDCs, will have high resistance to oxidation, degradation, corrosion and deformation at temperatures above 1400°C. The overall research program in PolyCerNet is divided into two topics: (A) NanoScience and (B) Scale-Up Processing. The first topic is concerned with the understanding of the molecular pathway for the evolution of the nanostructure of the ceramics via the polymeric route. The research includes molecular tailoring for non-linear optical properties, especially photo- and electroluminescence, and gas sensitive properties for applications such as high temperature sensors, hydrogen storage and catalytic electrodes for fuel cells. Topic B is concerned with the development of underlying experimental and theoretical techniques for commercial implementation of these technologies. This topic is therefore concerned with the fabrication of shapes from PDCs. Two particular geometries, fibers and porous structures are being investigated.

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<th>Partner</th>
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<td>1. U. of Trento</td>
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<td>2. U. Pierre et Marie Curie Paris</td>
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<td>3. Max Plank Inst.</td>
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<td>4. Poly. Univ. Bucharest</td>
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<td>5. Univ. of Padova</td>
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<td>6. Univ. Claude Bernard Lyone</td>
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<td>7. Technical Uni. Darmstadt</td>
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PostDoc Position, 2 yrs *(Available starting April 1st, 2006)*

**Chemical Methods for Ultahigh Surface Area SiCO-Based PDCs for “Hydrogen” Applications**

The objective of this project is to create novel high surface area PDC structures by etching. The etching has been shown to remove silica domains from SiCO thereby leaving behind carbon based skeletons which possess specific surface areas in excess of 600 m²/gm. These structures can be functionalized to inculcate hydrogen gas-sensing, storage and catalytic properties. The scientific investigation of the nanostructure of these etched materials, and their functionalization with elements such as B, and N in order to introduce gas sensitivity, are the dominant goals of this research effort. The precursors to be used in this work include hybrid silicon-alkoxides, cyclic siloxanes, and polyhedraloligomericsilsequioxanes (POSS).

The ideal candidate will have a PhD degree in Materials Science and Engineering, Materials Science or Chemistry. A good knowledge of the sol-gel process and of the main characterization techniques of the microstructure.

PhD student position, 3 yrs *(Available starting November 1st, 2006)*

**Optically Luminescent, Chemically Processed Si and Carbon-Based Quantum PDCs**

The aim of this research is focused on the molecular design, synthesis and optical characterization of PDCs. Two Ph.D. students, one from UTRP and the other from UTRM will work together towards these objectives. In this way the physics expertise in UTRP will be tightly coupled with the synthesis expertise at UTRM. One student will concentrate on the synthesis while the second will be more concerned with the optical characterization. The materials will be produced by the sol-gel chemical approach, which permits precise control of the composition and the size distribution of the nanoclusters. The photoluminescence and electroluminescence are the properties that will be studied and optimized. The specific objective of this work is to optimize chemistry and processing to achieve bright emission at high external quantum efficiency in the electroluminescence from the light emitting diode formed by silicon and silicon-carbide nanoclusters. The nanostructure will be characterized by the usual techniques (NMR, IR, Raman, ..) The optical properties will be studied.
by the following techniques: (a) luminescence, time resolved luminescence, luminescence excitation spectroscopy, (b) I-V measurements, electroluminescence measurements, and (c) absorption, reflection and m-line spectroscopy.
PhD student Position

Porous ceramics from preceramic polymers

The goal of this project is the development, from preceramic polymers, and characterization of porous ceramics with a hierarchical (micro-, meso- and macro-) porosity, for gas interaction applications. SiOC ceramic foams with a cell size in the <1 to ~500 micron range will be produced using various approaches. These macro-porous ceramics will be transformed into porous ceramics with hierarchical porosity by various means. Among them are: the development of nano-porosity using sacrificial fillers, the production of aerogels (and their introduction in the foams), the deposition of meso-porous coatings, etching of SiOC foams, use of phase separation. The development of porous ceramics with other compositions (Si-N-B-O-C) will also be investigated, as well as the use of nano-fillers of various nature to modify the composition or the properties (electrical, magnetic) of the functional porous ceramic products. The materials will have to be fully characterized for their morphology and selected properties. The activity will be performed in close cooperation with the other PolyCerNet partners.

The ideal candidate should have a Undergraduate or (better) a Master’s degree in Materials Science and Engineering or Materials Science. A good knowledge of the main characterization techniques of the microstructure and of the engineering properties of materials is required, as well as a good familiarity with polymeric and ceramic materials in general. The candidate should have the ability to develop (using available sources) the porous materials and fully characterize the morphology and selected properties of the materials produced. Moreover, he/she is expected to become well conversant with the relevant literature and to keep up-to-date with the novel developments in the field. Good knowledge of the English language is necessary, as well as the capability of conducting scientific research both autonomously and in a team-environment. Candidates with other degrees (Chemistry, Mechanical Engineering, Chemical Engineering) will also be considered, if the candidate previously took several courses in the field of Materials Science (materials science, polymers, metals, ceramics, characterization of materials, …). The possibility of obtaining a PhD in Materials Science and Engineering at the University of Padova is given.
PostDoc Position

Preparation and characterization of materials for gas-sensing applications

In this project suitable precursors for the preparation of non-oxide-based ceramic bulk materials with tailored porosity will be developed and synthesized in the Material Systems SiC, Si(B)CN and BCN. The incorporation of further elements like Mg, Li, Al, or Ca into these precursors will be considered. Suitable procedures have to be developed for thermolysis and reproducible pores architecture with respect to the avoidance of air and moisture, which represent a critical item in the case of the preparation of non-oxide-based materials. The polymer to ceramic transformation will be monitored by thermal analysis. The obtained materials will be characterized by IR and NMR spectroscopy, XRD, BET and electron microscopy.

The tasks comprises: (i) Chemical design and selection of PDCs for gas-sensing from Si-B-C-N system with various Mg, Li, Al and Ca dopings for gas-sensitivity, (ii) Creation of porous structures with optimized chemistries for hydrogen gas sensing properties and (iii) Providing chemically selected precursors for thin film fabrication for hydrogen sensors for project partners.

The job advertisement is targeted at chemists, material scientists, technical mineralogists or physicists.

PhD student position

Porous materials with high corrosion and oxidation resistance

Si(B)CN has been shown to possess thermal stability and high corrosion resistance at high temperatures. In order to use these materials for gas-sensing and hot-gas sieving, materials with tailored porosity need to be fabricates. The objective of this project is to synthesize and evaluate such porous structures for applications involving high temperature gas-solid interactions. If necessary fillers may be introduced to reduce crack formation during thermolysis. Polymers and Ceramics will be characterized by spectroscopic methods, thermal analysis, electron microscopy, BET and corrosion and oxidation tests. The gas sensing capability of the obtained materials and the utilization for hot gas sieving will be investigated in close cooperation with PolyCerNet – Partners.
The tasks comprises: (i) Chemical design and selection of PDCs for high temperature gas-solid interactions from Si(B)CN system, (ii) Creation of a optimized process to crack-free porous structures, (iii) Oxidation and corrosion tests on porous material which is thermally stable to high temperatures and (iv) Evaluation of gas sensing and hot gas sieving properties.

The job advertisement is targeted at chemists, material scientists, or technical mineralogists. The possibility for preparation of a PhD at Darmstadt University of Technology thesis is given.
PostDoc Position – Silico and boron based PDCs composites

In the continuation of the ceramic fibers activity, LMI proposes a Post-doc subject which deals with the fabrication